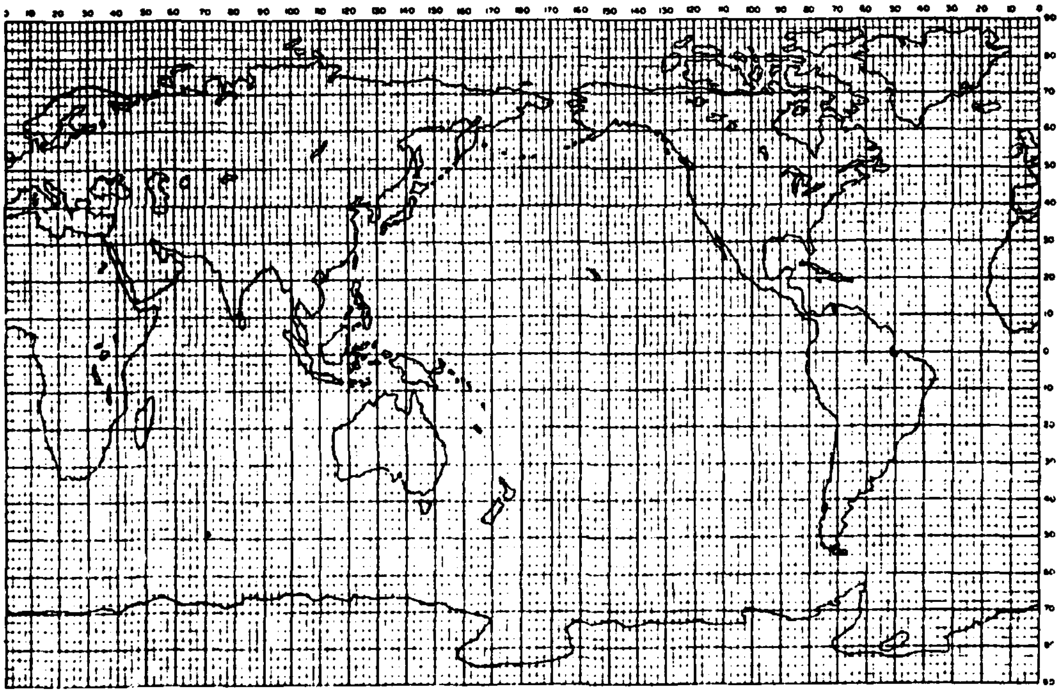
USAFETAC/UH-88/001
Revised

HIRAS

USAFETAC CLIMATIC DATABASE USERS HANDBOOK NO. 5

OCTOBER 1988
Revised February 1991



APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION IS UNLIMITED

USAF
ENVIRONMENTAL TECHNICAL APPLICATIONS CENTER
OPERATING LOCATION A
FEDERAL BUILDING, ASHEVILLE, NC 28801-2723

REVIEW AND APPROVAL STATEMENT

SAFETAC/UH-88/001, *HIRAS USAFETAC Climatic Database Users Handbook No. 5*, October 1988 (revised :bruary 1991), has been reviewed and is approved for public release. There is no objection to unlimited distribu- on of this document to the public at large, or by the Defense Technical Information Center (DTIC) to the National :chnical Information Service (NTIS).

OR THE COMMANDER

'ALTER S. BURGMANN
:ientific and Technical Information
rogram Manager
? February 1991

REPORT DOCUMENTATION PAGE

2. Report Date: October 1988 (Revised 1991)

3. Report Type: Users Handbook

4. Title: HIRAS USAFETAC Climatic Database Users Handbook No. 5

7. Performing Organization Names and Address: USAF Environmental Technical Applications Center Operating Location A, Federal Building, Asheville, NC 28801-2723

8. Performing Organization Report Number: USAFETAC/UH-88/001

11. Supplementary Notes: Revises and supersedes USAFETAC/UH-88/001.

12. Distribution/Availability Statement: Approved for public release; distribution is unlimited

13. Abstract: Provides users of USAFETAC's High Resolution Analysis System (HIRAS) Climatic Database with information on database history, production, and content. Also discusses processing and quality control, and tells users how to obtain the data.

14. Subject Terms: CLIMATOLOGY, COMPUTER APPLICATIONS, GLOBAL ANALYSIS, HIRAS, UPPER-AIR, DATABASES, METEOROLOGY

15. Number of Pages: 13

17. Security Classification of Report: Unclassified

18. Security Classification of this Page: Unclassified

19. Security Classification of Abstract: Unclassified

20. Limitation of Abstract: UL

Standard Form 298

HIRAS
CLIMATIC DATABASE USERS HANDBOOK NO. 5
OCTOBER 1988

This handbook was revised and reprinted in February 1991. Further page changes will be issued as required. For convenience, as well as for assurance that the contents reflect the most current version of the database, users are asked to post changes in the space below.

CHANGE NUMBER	CHANGE DATE

TABLE OF CONTENTS

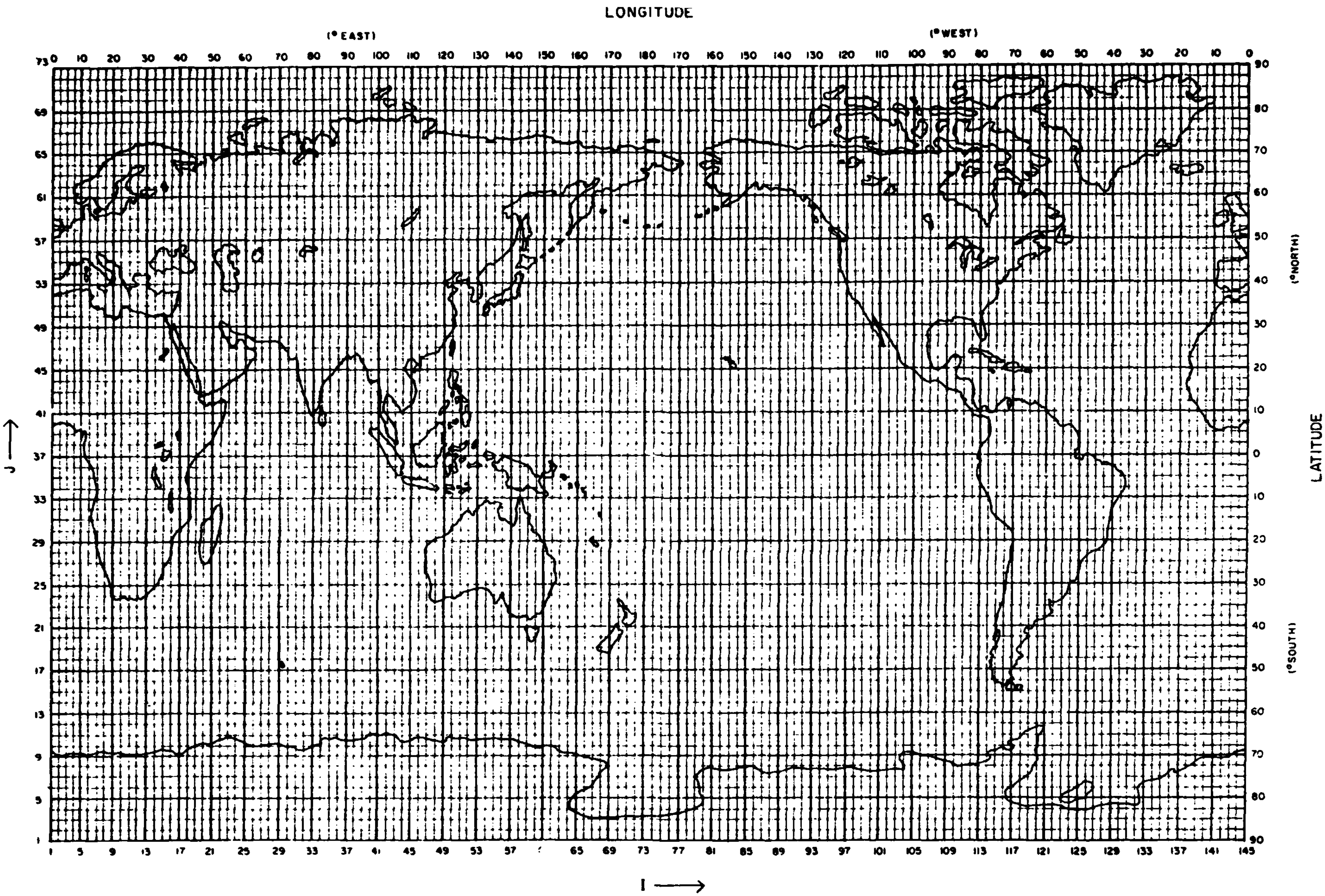
SECTION 1 INTRODUCTION

1.1 PURPOSE OF THE HANDBOOK. This handbook provides users of the High Resolution Analysis System (HIRAS) climatic database with information on its history, production, and content. It also discusses processing and quality control procedures, describes database format, and tells users how to obtain HIRAS climatic data.

1.2 HISTORY OF THE DATABASE. The Air Force Global Weather Central (AFGWC) at Offutt AFB, Nebraska, began operational production of the HIRAS upper-air analysis in August 1984. Operational production of AFGWC's upgraded Advanced Weather Analysis and Prediction System (AWAPS) HIRAS began in October 1985. USAFETAC's Operating Location A at Asheville, North Carolina, began building the HIRAS climatic database starting with January 1985 data. HIRAS is the primary upper-air analysis system used in AWAPS. It produces global upper-air analysis data every 6 hours. AFGWC sends that data to OL-A twice a day for inclusion in the HIRAS Climatic Database. The purpose of HIRAS and its connection with AWAPS are fully described in AWS/TN-86/001, *AFGWC's Advanced Weather Analysis and Prediction System (AWAPS)*, June 1986.

1.3 QUESTIONS AND COMMENTS. Address questions or comments on the HIRAS climatic database to OL-A, USAFETAC, Federal Building, Asheville, NC 28801 (AUTOVON 697-8358, Commercial 704-259-0224).

1.4 DATA ORDERING PROCEDURES. Department of Defense (DoD) customers should submit requests in accordance with AWSR 105-18 or Department of the Army Pamphlet 115-1. Non-DOD customers submit requests to the National Climatic Data Center (NCDC), Federal Building, Asheville, NC 28801-2723. Data is normally provided to customers on 6250 BPI magnetic tapes in the database format specified by this handbook.



THE HIRAS GRID

2.1 THE AFGWC HIRAS ANALYSIS MODEL. HIRAS is the primary upper-air analysis system used in AWAPS which, when installed in 1985, was a giant step forward in AFGWC numerical weather prediction. AWAPS includes three state-of-the-art models: the High Resolution Analysis System (HIRAS) discussed here, the Global Spectral Model (GSM), and the Relocatable Window Model (RWM). All these models run on AFGWC's Cray X-MP supercomputer. HIRAS produces global upper-air analyses on a 2.5 by 2.5 degree latitude/longitude grid. Levels available are sea level, surface, 1000, 850, 700, 500, 400, 300, 250, 200, 150, 100, 70, 50, 30, 20 and 10 millibars. The HIRAS model uses a variety of observations taken from land stations, ships, buoys, aircraft, RAOBs, PIBALs, rocketsondes, and satellites. The various meteorological elements produced by HIRAS are: pressure, temperature, height, U- and V-components of wind, relative and specific humidities, dewpoint depression, precipitable water, vorticity, and tropopause data. HIRAS analyzes five elements (heights, u- and v-component winds, temperature, and relative humidity) directly; all other HIRAS elements are derived from these five.

HIRAS has two main components: a "*first-guess*" (a version of GSM) and an *analysis* model. HIRAS uses an analysis technique called "optimum interpolation," or OI. The model itself is an adaptation of the OI analysis used at the National Meteorological Center (NMC). (For a detailed description of the NMC model, see *The NMC Spectral Model*, NOAA Technical Report NWS 30, by J. G. Sela, 1982.) Basically, OI takes three factors into account: (1) the distance between the observations and the grid point, (2) the accuracy of the observing instruments, and (3) the expected accuracy of the first-guess value. The following is a description of how HIRAS uses these three factors.

2.1.1. Distance Between Observation and Grid Point. This is the foundation of nearly every numerical analysis scheme; it is not unique to OI. The model assigns weights to the observations surrounding each grid point. In HIRAS, these weights decrease exponentially with distance. Each observation is allowed to affect the first-guess analysis depending on how close it is to the grid point. If a grid point has observations nearby, the first-guess value is corrected. If there are no nearby observations, the first-guess value remains unchanged. HIRAS allows up to 35 observations to influence the first-guess value at a grid point.

2.1.2. Accuracy of Observing Instruments. One of the major advantages of OI is its ability to distinguish between various observing instruments. It takes instrument errors into account by assigning every instrument type a unique "expected error" that has been determined statistically. The basic OI rule is that the lower the expected instrument error, the more weight that the observation will receive. For example, a 500mb temperature from a RAOB is probably more accurate than a 500mb temperature from a satellite. If these two observations are the same distance from the grid point, therefore, HIRAS will give the RAOB a greater weight.

2.1.3. Accuracy of the First-Guess. Each HIRAS analysis produces two types of fields: *analyses* and *errors*. The first type (analyses) are the standard grid-point analyses that have already been discussed. The error fields, however, are specialized fields unique to OI. Within the HIRAS model, the error fields are used as "running" standard deviations, and indicate how accurate the analysis is at each grid point. The more observations available, the better the analysis, and the lower the expected error. Over data-rich areas like North America and Europe, error values are low. But over data-sparse areas like the Indian Ocean, error values are high. Because of the differences in error values, HIRAS accepts the quality of the first-guess over North America and Europe more readily than it does over the Indian Ocean. For a more detailed discussion of AWAPS, HIRAS, GSM and OI, see AWS/TN-86/001, *AFGWC's Advanced Weather Analysis and Prediction System (AWAPS), June 1986.*

2.2 INITIALIZATION. The HIRAS upper-air analysis provides all the initial conditions for the GSM and for the first-guess models. These initialized fields are stored as 0-hour GSM forecast fields. All HIRAS fields are stored as uninitialized data. The main purpose of an initialization scheme is to control mathematical instabilities that result from minor perturbations in the input data that the model can't resolve. These perturbations could be real (from micro- or sub-grid scale phenomena) or fictitious (from small observational errors). Because of this, nearly every numerical forecast model uses some form of initialization.

2.3 THE HIRAS GRID. HIRAS is produced on a 2.5 degree by 2.5 degree latitude/longitude grid, as shown on the opposite page. Each grid point is assigned an "I" and "J" coordinate. "I" begins at 0 degrees East and proceeds eastward in 2.5-degree increments; there are 145 "I's" in each latitude band. "J" begins at 90 degrees South latitude and proceeds northward in 2.5-degree increments; there are 73 "J's" on each HIRAS grid longitudinal line from the South Pole to the North Pole.

3.1 BUILDING THE DATABASE. The HIRAS analysis is received at OL-A, USAFETAC, from AFGWC via "GEON" (the "Global ETAC/OL-A Network"), a satellite communications system dedicated to such data transfers. Four analysis hours are received daily, at 00, 06, 12 and 18Z. Each hour contains an analysis for 98 level-elements (see fields C08 and C09 below). Each level-element analysis for the globe is divided into five records, with each record containing a global region that covers approximately 35 degrees of latitude.

3.2 THE DATABASE FORMAT. The HIRAS Climatic Database format is a fixed-length, 13,124 ASCII character record (8 bits/character). Each record is divided into these three sections:

- A *Control* Section (72 characters) contains record ID information.
- A variable-length *Data* section contains the data for 2,030 or 2,175 grid points (the number of grid points depends upon the record number within the five records representing a level-element).
- A *"Filler"* section contains ASCII blanks (" ") to fill the record to 13,124 characters. Prior to 1 July 1988, one month's data is stored on four 9-track, 6250 BPI magnetic tapes; after 1 July, one month's data requires *seven* tapes. Data is sorted by YEAR/MONTH/DAY/HOUR/LEVEL/ELEMENT.

	CONTROL SECTION													
Field	C01	C02	C03	C04	C05	C06	C07	C08	C09	C10	C11	C12	C13	C14
Data Field	RCD LNG	DATA TYPE	GLOBL REG	YEAR	MO	DA	HR	LEVEL	ELE	BGN J	END J	BGN I	END I	# of GRID PTS
# Char.	XXXX	XX	XX	XXXX	XX	XX	XX	XXXX	XX	XXX	XXX	XXX	XXX	XXXX
Location	1-4	5-6	7-8	9-12	13-	15-	17-	19-22	23-	25-	28-	31-	34-	37-40

	CONTROL SECTION cont.				DATA SECTION				FILLER SECTION
Field	C15	C16	C17	C18	data	data	..	data	
Data Field	# of CHARS	RCD #	# of RCDS	OPEN	for Grid Point1	for Grid Point2	..	for last Gr. Pt	ASCII BLANKS
# Char.	XXXX	XXXX	XXXX	XXX-XXX	XXXXXX	XXXXXX	..	XXXXX	XX..XXXXXXXXXX
Location	41-44	45-48	49-52	53 - 72	73 to 12252 or 13122				to 13124

CONTROL SECTION:

FIELD	DESCRIPTION OF FIELD AND COMMENTS
C01	RCD LNG. Record Length, coded as 3281 Words (4 characters/word)

TOTAL RECORD LENGTH (in characters)

RECORD No	
1, 5	72(control)+12180(data)+872(blanks)=13124
2, 3, 4	72(control)+13050(data)+ 2 (blanks)=13124

C02	DATA TYPE. Data Type 01 = Gridded Analysis Data.

FIELD	DESCRIPTION OF FIELD AND COMMENTS

C03 GLOBAL REG. Global Region, coded as follows:

Code	RCD #	Description	Beginning:	Ending:	# of Grid Pts
SP	1	South Polar	90S,0E(J1,I1)	57.5S,0E(J14,I145)	2030
SM	2	South Mid-Lat	55S,0E(J15,I1)	20S,0E (J29,I145)	2175
TR	3	Tropical	17.5S,0E(J30,I1)	17.5N,0E(J44,I145)	2175
NM	4	North Mid-Lat	20N,0E(J45,I1)	55N,0E (J59,I145)	2175
NP	5	North Polar	57.5N,0E(J60,I1)	90N,0E (J73,I145)	2030

C04 YEAR. Coded as 1985, 1986, 1987, 1988, etc.

C05 MONTH. Coded as 01 - 12 = JAN - DEC.

C06 DAY. Coded as 01 - 31.

C07 HOUR. Coded as 00, 06, 12, or 18 (GMT).

C08 LEVEL. Level or Layer, coded as follows:

Code	Level	Code	Level
0001	Sea Level	0013	70
0002	Surface	0014	50
0003	1000	0015	30
0004	850	0016	20
0005	700	0017	10
0006	500	0025	Tropopause
0007	400	0030	SURF - 850
0008	300	0031	850 - 700
0009	250	0032	700 - 500
0010	200	0033	500 - 400
0011	150	0034	400 - 300
0012	100	0035	300 - 100

C09 ELEMENT. Meteorological Element, coded as follows:

Code	Element name:	Data stored:	Valid Range:
01	Pressure	in tenths of MB x 10	000000 - 999998
02	U-wind Component	in tenths of M/S x 10	-99999 - 999998
03	V-wind Component	in tenths of M/S x 10	-99999 - 999998
04	D-value	in meters x 10	-99999 - 999998
05	Temperature	in tenths of deg K x 10	000000 - 999998
06	Dewpoint Depression	in tenths of deg K x 10	000000 - 999998
07	Specific Humidity	KG/(KG x 10^5)	000000 - 999998
08	Precipitable Water	in mm x 100	000000 - 999998
09	Height	in tenths of meters x 10	000000 - 999998
10	Vorticity	in radians/(sec x 10^6)	-99999 - 999998
11	Relative Humidity	in tenths of percent x 10	000000 - 999998
12	Tropopause Temp	in tenths of deg K x 10	000000 - 999998
20	H = # of hours since parcel crossed land	in whole hours	000000 - 999998

MISSING element values will be coded as 999999.

FIELD	DESCRIPTION OF FIELD AND COMMENTS
C10	BGN J. Beginning Latitude Indicator for record (see field C03 and para 2.3). Coded as 001, 015, 030, 045, or 060.
C11	END J. Ending Latitude Indicator for record (see field C03 and para 2.3). Coded as 014, 029, 044, 059, 0r 073.
C12	BGN I. Beginning Longitude Indicator for record (see field C03 and para 2.3). Coded as 001.
C13	END I. Ending Longitude Indicator for record (see field C03 and para 2.3). Coded as 145.
C14	# of GRID PRS. Coded as 2030 0r 2175.
C15	# of CHARS. Number of characters per gridpoint. Coded as 0006.
C16	RECORD #. Number of this record. Coded as 0001-0005.
C17	# of RCDS. Coded as 0005.
C18	OPEN. Coded as ASCII blanks.

DATA SECTION:

FIELD	DESCRIPTION OF FIELD AND COMMENTS
	DATA. 2030 or 2175 values of 6 ASCII numeric characters each, representing the grid points in a global region.

FILLER SECTION:

FIELD	DESCRIPTION OF FIELD AND COMMENTS
	BLANKS. Each record will end with two or 872 ASCII Blanks. (see field C01)

3.3 ELEMENTS AVAILABLE, BY LEVEL:

ELEMENT: \ LEVEL:	SLVL	SFC	1000	850	700	500	400	300	250	200	150	100	70	50	30	20	10	TROP	SF85	8570	7050	5040	4030	3010
PRESSURE	X																	X						
U-WIND		$\underline{X}$	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							
V-WIND		$\underline{X}$	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							
D-VALUE			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							
TEMPERATURE		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							
DEWPOINT DEPRESSION		$\underline{X}$	$\underline{X}$	$\underline{X}$	$\underline{X}$	$\underline{X}$	$\underline{X}$	$\underline{X}$																
SPECIFIC HUMIDITY		$\underline{X}$	X	X	X	X	X	X																
PRECIPITABLE WATER																			$\underline{X}$	$\underline{X}$	$\underline{X}$	$\underline{X}$	$\underline{X}$	$\underline{X}$
HEIGHT																		X						
VORTICITY				$\underline{X}$		$\underline{X}$		$\underline{X}$																
RELATIVE HUMIDITY		$\underline{X}$	$\underline{X}$	$\underline{X}$	$\underline{X}$	$\underline{X}$	$\underline{X}$	$\underline{X}$																
TROPOPAUSE TEMPERATURE																		X						
H (# hours since land)		$\underline{X}$																						

NOTE: $\underline{X}$ Elements not available before 1 July 1988: surface u-wind & v-winds; dewpoint depression; surface specific humidity; precipitable water; vorticity; relative humidity; and surface hours since land.

SECTION 4 DATA PROCESSING AND QUALITY CONTROL

4.1 DATA PROCESSING AT OL-A. OL-A processes HIRAS analysis data by:

- Inventorying incoming data from AFGWC,
- Processing data through a database build program that combines daily data into a monthly file and produces an audit of the database tape reels.
- Quality controlling the database.

4.2 QUALITY CONTROL AT AFGWC. The HIRAS data quality control applied at AFGWC includes *manual* and *automated* checks. Forecasters at AFGWC perform the manual checks by adding "bogus" observations or deleting real observations. If they believe anything to be erroneous while reviewing the first-guess model output, forecasters can introduce artificial, or "bogus" data for use in the subsequent analysis. For example, if they think the first-guess has moved an upper-air trough too far east, AFGWC QC'ers can introduce bogus data that moves it back where it belongs. The analysis then uses the bogus data to correct the first-guess analysis.

Automated quality control is directed at throwing out bad observations. The first steps in this process are called "gross checks," during which HIRAS compares each observation with the first-guess analysis. If an observation grossly disagrees with the first-guess (that is, if the difference between the observed value minus the first guess value exceeds the analysis error field for the analysis point under consideration by more than eight error standard deviations), it is immediately rejected. If an observation just barely passes the gross checks (that is, if the observed value minus first guess value differ by between three and eight standard deviations), it is flagged and submitted to a second procedure, called the "buddy check." Here, all the observations that just barely passed gross checks are compared with nearby, or "buddy" observations. If one of these flagged observations significantly disagrees with its "buddy" (that is, if the difference between the two values is more than four times the analysis error at the analysis point being considered), it is rejected.

4.3 QUALITY CONTROL AT OL-A. As programming resources allow, OL-A checks HIRAS analysis data against gross and suspect limits. Any data identified by these checks will be flagged to indicate which check it failed. OL-A is also developing procedures for spatial and temporal QC of the data.

4.4 KNOWN PROBLEMS:

- Moisture analyses prior to 21 March 1988 at 1200Z are not from HIRAS, but from the old MULTAN model.
- Prior to April 1987, the model generated abnormally deep lows in the southern hemisphere south of 60 degrees south. Data below 500 millibars was most severely affected.
- Prior to 1 July 1988, the data elements H, vorticity, precipitable water, dew point depression, and relative humidity are not available
- **The element called "surface temperature" is actually an extrapolation from the 1,000-millibar temperature analysis. This data is not surface temperature and should not be used as such. In addition, surface elements u-wind, v-wind, and specific humidity are not available before 1 July 1988.**

DISTRIBUTION

AWS/DO, Scott AFB, IL 62225-5008 ... 1
AWS/DOOX, Scott AFB, IL 62225-5008 ... 1
AWS/XTXA Scott AFB, IL 62225-5008 ... 1
1WW/DN, Hickam AFB, HI 96853-5000 ... 2
2WW/DN, APO New York 09094-5000 ... 2
3WW/DN, Offutt AFB, NE 68113-5000 ... 2
4WW/DN, Peterson AFB, CO 80914-5000 ... 2
  2WS/DON, Andrews AFB, MD 20334-5000 ... 20
5WW/DN, Langley AFB, VA 23665-5000 ... 2
AFGWC, Offutt AFB, NE 68113-5000 ... 10
  USAFETAC, Scott AFB, IL 62225-5438 ... 10
  OL-A, USAFETAC, Federal Building, Asheville, NC 28801-2723 ... 30
7WW/DN, Scott AFB, IL 62225-5008 ... 2
3350 TCHTG/TTGU-W, Stop 62, Chanute AFB, IL 61868-5000 ... 1
3395 TCHTG/TTKO, Keesler AFB, MS 39534-5000 ... 1
AFIT/CIR, Wright-Patterson AFB, OH 45433-6583 ... 1
AFCSA/SAGW, Washington, DC 20330-5000 ... 1
NAVOCEANCOMDET, Federal Building, Asheville, NC 28801-2723 ... 1
COMNAVOCEANCOM, Code N312, Stennis Space Ctr, MS 39529-5000 ... 1
NCDC Library (D542X2), Federal Building, Asheville, NC 28801-2723 ... 1
DTIC-FDAC, Cameron Station, Alexandria, VA 22304-6145 ... 2
AUL/LSE, Maxwell AFB, AL 36112-5564 ... 1
AWSTL, Scott AFB, IL 62225-5438 ... 100